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10/507029

DT15 Rec'd PCT/PTO 08 SEP 2004

DESCRIPTION

COMPRESSOR

TECHNICAL FIELD

The present invention relates to a compressor used in air conditioner for automobile or the like, among compressors for compressing refrigerant.

BACKGROUND ART

In a compressor for compressing fluid, part of lubricating oil for lubricating sliding parts of a compressing mechanism is discharged from the compressor together with compressed fluid, and circulates in refrigerating and air conditioning cycle. As the quantity of lubricating oil discharged into the cycle together with the fluid increases, the system efficiency (heat efficiency) declines. Accordingly, to enhance the system efficiency, the contained lubricating oil is separated as much as possible from the fluid compressed by the compressing mechanism. The separated fluid is discharged into the system cycle. Such examples are disclosed in Japanese Laid-open Patent No. H11-82352 (Fig. 1, Fig. 3, Fig. 4), and Japanese Laid-open Patent No. 2001-295767 (Fig. 1, Fig. 2). In such conventional compressor comprising a centrifugal separation chamber, high pressure refrigerant gas containing lubricating oil compressed by the compressing mechanism is guided into the centrifugal separation chamber. This refrigerant gas revolves in the circular columnar separation chamber. By centrifugal force of this revolution, the misty lubricating oil contained in the refrigerant gas contacts with the inner wall of the separation chamber. As a result, the misty lubricating oil is separated from the refrigerant gas. The conventional compressor comprising the centrifugal separation

ATTACHMENT B

chamber has pipes called separation pipes provided in all parts of the separation chamber. The refrigerant gas introduced into the separation chamber revolves in a cylindrical space of circular section formed between the separation pipe outer circumference and separation chamber inner circumference. Thus, in the centrifugal lubricating oil separation system, generally, separation pipes are regarded to be essential constituent elements. That is, to enhance the separation efficiency of lubricating oil, the refrigerant gas must be revolved securely in the separation chamber. For this purpose, it is considered essential to install separation pipes in the separation chamber and revolve the refrigerant gas on the circumference. Such system of installing separation pipes in the separation chamber results in large size of separation chamber. Moreover, the number of parts is increased, the manufacturing cost of separation chamber is raised, the number of processes increased for assembling the separation pipes, and thereby it is a serious problem to reduce the manufacturing costs of the compressor.

It is hence an object of the invention to solve the conventional problems and present a compressor high in separation efficiency of lubricating oil, reduced in the size of compression chamber, and lowered in manufacturing cost.

DISCLOSURE OF THE INVENTION

The invention presents a compressor comprising a compressing mechanism for compressing a fluid that contains lubricating oil, and a separation chamber that is revolved by having introduced thereinto the fluid compressed by the compressing mechanism and in which at least part of the lubricating oil contained in the fluid is separated by the centrifugal force produced by this revolution, in which only the introduced fluid is present in the separation chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a longitudinal sectional view showing an example of compressor in a preferred embodiment.

Fig. 2 is a sectional view A-A (operation chamber sectional view) of the compressor shown in Fig. 1.

Fig. 3 is a sectional view B-B (high pressure case seen from operation chamber side) of the compressor shown in Fig. 1.

Fig. 4 is a sectional view C-C near the separation chamber of the compressor shown in Fig. 1.

Fig. 5 is a diagram showing the relation of degree of eccentricity (L/R) of feed hole in separation chamber and oil circulation rate (OCR).

Fig. 6 is a longitudinal sectional view showing other example of high pressure case of the preferred embodiment shown in Fig. 1.

Fig. 7 is a lateral sectional view near separation chamber showing other example of slender passage of the preferred embodiment shown in Fig. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of the invention is described below while referring to the accompanying drawings. Drawings are schematic diagrams, and do not represent the configuration of parts in correct dimensions.

(Preferred embodiment)

The compressor shown in Fig. 1 to Fig. 3 is a so-called vane rotary type compressor, and circular columnar rotor 2 is disposed in cylinder 1 having a cylindrical inner wall. Rotor 2 is disposed at such position that part of its outer

circumference may form a slight gap to the inner wall of cylinder 1.

Rotor 2 includes a plurality of vane slots 3. Vane 4 is slidably inserted in each vane slot 3.

Rotor 2 is formed integrally with driving shaft 5 which is rotatably supported. Cylinder 1 and rotor 2 are inserted between front plate 6 and rear plate 7 in the rotary shaft direction of rotor 2.

Both ends of cylinder 1 are closed by them, and operation chamber 8 is formed in cylinder 1 for compressing a fluid.

Suction port 9 and discharge port 10 communicate with operation chamber 8. Fluid such as refrigerant gas is sucked from suction port 9 into operation chamber 8, and compressed and discharged from discharge port 10. At the outlet of discharge port 10, discharge valve 11 composed of, for example, reed valve is disposed.

High pressure case 12 is installed at the rear side of rear plate 7.

High pressure case 12 includes separation chamber 51 for separating and collecting misty lubricating oil contained in the refrigerant gas compressed in operation chamber 8. The fluid compressed in operation chamber 8 and discharged from discharge port 10 flows into guide passage 13 provided continuously in cylinder 1, rear plate 7 and high pressure case 12. The fluid further passes through feed hole 53 formed in the side wall of separation chamber 51, and flows into separation chamber 51.

In the upper part of separation chamber 51, gas exhaust hole 58 for exhausting refrigerant gas from which lubricating oil is separated in separation chamber 51 has an opening.

In the lower part of separation chamber 51, oil discharge hole 54 for discharging lubricating oil separated from refrigerant gas and collected in separation

chamber 51 has an opening.

The refrigerant gas exhausted through gas exhaust hole 58 from separation chamber 51 circulates in refrigerating and air conditioning cycle. The refrigerant gas returns to suction port 9, and is compressed again and circulates in refrigerating and air conditioning cycle.

Oil discharge hole 54 having an opening in the lower part of separation chamber 51 communicates with oil-storage chamber 52 formed between high pressure case 12 and rear plate 7. Therefore, the lubricating oil separated and collected from the refrigerant gas in separation chamber 51 passes through oil discharge hole 54 and is stored in oil-storage chamber 52.

The lubricating oil stored in oil-storage chamber 52 is supplied into rotor 2, vane 4, inner wall of cylinder 1 and other parts through oil-supply passage 18, and lubricates the parts. The lubricating oil is further supplied into vane back pressure chamber 17, and works to force vane 4 to outside of rotor 2 by its pressure.

The lubricating oil is supplied through oil-supply passage 18 for supplying lubricating oil from oil-storage chamber 52 into the compressing mechanism. In oil-supply passage 18, the lubricating oil stored in oil-storage chamber 52 is supplied through vane back pressure adjusting apparatus 16. Depending on the refrigerant gas pressure around the compressing mechanism, vane back pressure adjusting apparatus 16 controls the feed pressure and feed amount of lubricating oil to be supplied into the compressing mechanism.

The operation of the compressor in this preferred embodiment is described below.

Receiving power transmission from a driving source such as car-mount engine, as shown in Fig. 2, driving shaft 5 and rotor 2 rotate clockwise. By this rotation,

refrigerant gas of low pressure flows into operation chamber 8 from suction port 9.

Along with rotation of rotor 2, compressed refrigerant gas of high pressure pushes up discharge valve 11 from discharge port 10, and flows into guide passage 13. Further, the refrigerant of high pressure passes through feed hole 53, and flows into separation chamber 51. In separation chamber 51, the lubricating oil contained in the refrigerant gas is separated and collected. Separation chamber 51 shown in Fig. 1 is a so-called centrifugal oil separator. It is composed by mutually coupling circular columnar space 49 and inverted conical space.

The inside of separation chamber does not include separation pipes used in conventional centrifugal compressor. The inside of separation chamber is a hollow space, and only the introduced refrigerant gas (partly mixing the lubricating oil contained in the compressor) is present. Further, the inside of separation chamber is free from bumps and dents which may disturb revolution of refrigerant gas introduced in separation chamber 51. Feed hole 53 is disposed eccentrically from the central axis of circular columnar space 49 of separation chamber 51. The refrigerant gas introduced into separation chamber 51 is guided in the tangential direction of circular columnar space 49. That is, the refrigerant gas flows into separation chamber 51 along the inner circumference of circular columnar space 49. Therefore, the refrigerant gas introduced into separation chamber 51 revolves in the peripheral direction in separation chamber. By the centrifugal force of revolution, the lubricating oil of heavier specific gravity contacts with the inner wall of separation chamber, and is separated from the refrigerant gas.

The separated lubricating oil moves down along inner circumference 49, and is collected in the center by the inverted conical space.

Between the upper part of oil-storage chamber 52 and separation chamber 51,

communication passage 57 is provided for communicating them mutually. Like feed hole 53, communication passage 57 is provided eccentrically from the central axis of separation chamber 51.

In this structure, the fluid introduced into separation chamber 51 through communication passage 57 is guided into the tangential direction of circular columnar space 49. That is, the fluid flows into separation chamber 51 along the inner circumference of circular columnar space 49. As a result, the fluid flowing into separation chamber 51 from oil-storage chamber 52 through communication passage 57 smoothly converges on revolution of refrigerant gas in separation chamber. That is, disturbance of revolution of refrigerant gas can be suppressed. If the lubricating oil in oil-storage chamber 52 reaches up to communication passage 57 due to some cause, the lubricating oil is guided into separation chamber 51 by way of communication passage 57. Since the flowing direction of lubricating oil into separation chamber 51 is a direction to converge on the revolving flow in separation chamber as mentioned above, revolution of refrigerant gas in separation chamber is not disturbed.

In the case of the compressor of this preferred embodiment, the opening at the oil-storage chamber side of oil discharge hole 54 is positioned below the oil level in oil-storage chamber 52 in the perpendicular direction.

Accordingly, the refrigerant gas of high pressure discharged from the compressing mechanism acts to push down the oil level of lubricating oil collected in the lower part of separation chamber 51, and also push up the oil level of lubricating oil in oil-storage chamber 52.

However, when the lubricating oil in oil-storage chamber 52 is pushed up, the fluid (mainly refrigerant gas) gathering in the upper part of oil-storage chamber 52

may disturb elevation of oil level of lubricating oil in oil-storage chamber 52.

In this preferred embodiment, between the upper part of the oil-storage chamber 52 and separation chamber 51, communication passage 57 is provided for allowing the fluid to move freely between them. Communication passage 57 functions as gas vent hole of fluid such as refrigerant gas gathering in the upper part of oil-storage chamber 52. As a result, the oil level of lubricating oil in oil-storage chamber 52 can be pushed up smoothly.

Communication passage 57 is provided so that the fluid flowing into separation chamber 51 from oil-storage chamber 52 may not disturb revolution of refrigerant gas in separation chamber 51. For this purpose, the flowing direction of fluid from oil-storage chamber into separation chamber should not have direction component of facing and colliding the revolving flow near the outlet of communication passage. Therefore, the communication passage may be provided along a direction orthogonal to the central axis of separation chamber.

In the preferred embodiment, the opening of oil discharge hole 54 at the side of oil-storage chamber 52 is positioned lower than the oil level in oil-storage chamber in the perpendicular direction. However, the opening be also positioned higher than the oil level.

In this case, the oil level push-up effect by refrigerant gas of high pressure is not expected. However, since communication passage 57 is provided, blow-back from oil discharge hole 54 by pulsation of refrigerant gas can be suppressed. Therefore, it is expected to suppress scattering of the oil collected in the lower part of separation chamber 51 into separation chamber by blow-back.

It is a feature of the compressor of the invention that separation pipes are not provided in separation chamber in spite of the structure having the so-called

centrifugal separation chamber. Elimination of separation pipes is realized by the following four technical factors.

A first factor is the relative configuration of the feed hole for feeding compressed refrigerant gas into separation chamber and the separation chamber. The relative configuration refers to the degree of eccentricity of the feed hole from the central axis of the separation chamber. The degree of eccentricity is specifically described below.

As shown in Fig. 4, suppose the distance from central axis M of separation chamber 51 to inner peripheral wall of circular columnar space 49 to be R. Further, suppose the shortest distance from central axis M to projection line of the opening of lead hole 53 projected in the tangential direction (direction parallel to the central axial line of feed hole) of columnar circular space 49 to be L. When thus defined, the ratio of L and R (L/R) is the degree of eccentricity. Assuming the range of value of L to be 0 at minimum and R at maximum, the degree of eccentricity (L/R) is a value from 0 to 1.

The larger this value, the more eccentric is the feed hole to the separation chamber. The relation between the degree of eccentricity and oil circulation rate (OCR) is compared between the case having separation pipes in the separation chamber and the case not having such pipes. The relation of the two is qualitatively shown in Fig. 5.

The OCR is defined in Japanese Industrial Standards (JIS B 8606). That is, the OCR represents the mass of lubricating oil in mixed solution relative to the mass of mixed solution of liquid refrigerant and lubricating oil lubricating in the cycle, and the unit is percentage. A smaller value of OCR shows a higher oil separation efficiency. In Fig. 5, curve A represents the case with separation pipes and curve B

without separation pipes. As shown in Fig. 5, in a region of small degree of eccentricity, the OCR is smaller in the case with separation pipes. As the degree of eccentricity becomes higher, the OCR difference narrows, and curve A and curve B intersect. At higher degree of eccentricity, the OCR values of curve A and curve B are inverted. Therefore, to present a refrigerating and air conditioning system of high efficiency by eliminating separation pipes, it is preferred to define the degree of eccentricity higher than the degree of eccentricity corresponding to the intersection of both curves shown in Fig. 5. The present inventors discovered by simulation that the preferred degree of eccentricity (L/R) should be 0.4 or more. Meanwhile, L may be defined as the distance from the central axis M of the separation chamber to the axis of center of gravity of section of feed hole. In this case, the degree of eccentricity may be 0.7 or more although variable depending on the shape of feed hole. Thus, a refrigerating and air conditioning system of higher efficiency (lower OCR) is presented without using separation pipes as compared with the case having such pipes.

A second factor is the configuration of gas exhaust hole 58 for exhausting refrigerant gas after separation of oil from the separation chamber and the opening of separation chamber 51. In the preferred embodiment shown in Fig. 1, the opening of gas exhaust hole 58 is provided in the central part of upper end side of circular columnar space 49 of separation chamber.

The sectional area of the opening of gas exhaust hole 58 is formed smaller than the sectional area of circular columnar space 49. The opening of gas exhaust hole 58 does not reach up to the outer circumference of circular columnar space 49. At the upper end of circular columnar space 49, reducing portion 56 is formed for reducing the inside diameter of circular columnar space 49 to the inside diameter of

opening of gas exhaust hole. That is, the opening of gas exhaust hole 58 is coupled to the upper end side outer circumference of circular columnar space 49 by way of this reducing portion 56. It hence suppresses escape of refrigerant gas of high density and high speed containing much lubricating oil mist and introduced into separation chamber, from the separation chamber by hardly revolving in separation chamber 51. That is, assuming the flow velocity of refrigerant gas introduced into the separation chamber not to decline while revolving, the refrigerant gas (of high density) containing much lubricating oil mist of high specific gravity revolves around the outer circumference of the revolving flow along the inner wall of circular columnar space 49. As separation of lubricating oil is promoted, it gradually moves into the center of revolution as being pushed away by the refrigerant gas of high density. Finally, gas is considered to be exhausted from the gas exhaust hole.

Actually, the refrigerant gas right after being introduced in the separation chamber is fastest in flow velocity, and the flow velocity declines gradually during revolution. As the flow velocity declines, the centrifugal force acting on the refrigerant gas decreases. Accordingly, the refrigerant gas of high density and high speed containing lubricating oil mist revolves on the outer circumference of the revolving flow along circular columnar space 49 in the separation chamber. As separation of lubricating oil is promoted, the refrigerant gas lowered in density and speed moves into the center of revolution, and is exhausted from the gas exhaust hole. It hence suppresses escape of refrigerant gas of high density and high speed containing much lubricating oil mist and introduced into separation chamber, from the separation chamber by hardly revolving in separation chamber 51. In the preferred embodiment shown in Fig. 1 and Fig. 4, reducing portion 56 is formed as an upper end at right angle to the central axis of circular columnar space 49.

However, it is not always limited to this structure. The reducing portion 56 may be formed as a slope inclined obliquely to the central axis of the circular columnar space. It may be also formed as a moderate curve consecutive from the outer circumference of the circular columnar space. As far as the reducing portion is present in the entire circumference of the opening of gas exhaust hole 58, the central axis of gas exhaust hole may be eccentric from the center of separation chamber.

A third factor is adjustment of direction of slender passage 21 communicating with feed hole 53 as shown in Fig. 6. That is, the refrigerant gas introduced in separation chamber 51 flows into separation chamber 51 in a direction departing from the opening of gas exhaust hole 58. In this manner, at least the refrigerant gas containing much lubricating oil mist and right after being introduced in separation chamber 51 can be moved away from the opening of gas exhaust hole 58. Thus, the refrigerant gas containing much lubricating oil mist right after introduction can be suppressed from being supplied into the refrigerating and air conditioning system from gas exhaust hole 58.

Meanwhile, if inclination angle α of central axis N of slender passage 21 and central axis M of separation chamber is too small, the flow velocity of refrigerant gas introduced into separation chamber 51 cannot be utilized in revolution in separation chamber. As a result, it is considered that the OCR may drop. In order to obtain a high OCR, inclination angle α is preferred to be 60 degrees or more to 90 degrees or less.

As the inner circumference of the circular columnar space is departed from the gas exhaust hole, it is expanded, and an inner wall of columnar space is formed. As a result, the refrigerant gas of high density and high speed introduced in separation chamber receives a centrifugal force, and is guided into the most expanded inner

circumference. Hence, without inclining slender passage 21 to central axis M of separation chamber, it is preferable because the refrigerant gas containing much lubricating oil mist and introduced in the separation chamber can be departed from the opening of gas exhaust hole 58.

A fourth factor is that slender passages 13A (see Fig. 1) and 21 (see Fig. 7) formed consecutively to feed hole 53 are provided in guide passage 13 for guiding refrigerant gas from discharge port 10 of compressing mechanism to feed port 53 into separation chamber 51.

In this structure, these slender passages (13A and 21) have an action of straightening the refrigerant gas introduced into separation chamber 51. That is, disturbance or diffusion of flow of fluid flowing into separation chamber 51 can be suppressed. Moreover, not only the static pressure of the refrigerant gas of high pressure discharged from the compressing mechanism but also dynamic pressure can be effectively utilized in revolution of refrigerant gas in separation chamber 51.

Four technical factors enabling to eliminating separation pipes are explained. These plural technical factors can be combined, and combined effects of these technical factors are expected. Further, these individual technical factors of the preferred embodiment can be further combined with other technical elements.

In one example of the preferred embodiment, a circular columnar space is explained as a columnar space of separation chamber. However, the columnar space may have any sectional shape as far as the revolution of introduced refrigerant gas is not disturbed. For example, same effects are obtained by an elliptical section or quadrilateral shape with round corners. The compressor having a centrifugal oil separation chamber of the invention can get rid of separation pipes in oil separation chamber. Since separation pipes are not needed, space for installing separation

pipes in the separation chamber is not needed. As a result, the separation chamber is reduced in size. It is further possible to lower the manufacturing cost of compressor due to fabrication and assembling of separation pipes. The fluid in the compressor of the invention means gas containing misty liquid.

INDUSTRIAL APPLICABILITY

The invention is not limited to sliding vane type rotary compressor, but may be applied in rolling piston type, scroll type, and other compressors.